

**PAPER MACHINE CLOTHING WITH WEAR-RESISTANT WEAVE**

The present invention relates to papermachine clothing and more particularly, but not exclusively, to dryer fabrics for use in the dryer section of a papermaking machine.

5 Paper is conventionally manufactured by conveying a paper furnish, usually consisting of an initial slurry of cellulosic fibres, from a forming section, through a pressing section and ultimately around a drying section of a papermaking machine.

Papermachine clothing is essentially employed to carry the paper web  
10 through these various stages of the papermaking machine. In the forming section the fibrous furnish is wet-laid onto a moving forming wire and water is allowed to drain from it. The paper web is then transferred to a press fabric that conveys it through the pressing section, where it is usually passed through a series of pairs of rotating cylindrical press rolls. Water is squeezed from the paper web and into the  
15 press fabric as the web and fabric pass through the nip together.

In the final stage the paper web is transferred to a dryer fabric in the dryer section of the papermaking machine. The dryer section conventionally includes a number of rotatable dryer drums or cylinders heated from within by steam. The web is directed over each of these drums by the dryer fabric which holds the web  
20 against the surface of the heated drums. In this way the majority of the remaining water is evaporated from the paper web.

Dryer fabrics are generally formed from materials which are resistant to hydrolytic degradation under high temperatures. However, these materials are prone to abrasion. Consequently the dryer fabrics made from these materials have

unacceptably short lives. Numerous solutions have been proposed to this problem. These solutions sometimes involve varying the constituent polymer of the fabric yarns, such as in US 5,692,938 or varying the weave pattern, such as in US 6,158,478 and US 5,503,196.

5 US 6158478 relates to a multilayer woven dryer fabric having a weave pattern in which less knuckles are formed on the machine-side of the fabric than on the paper-side by reducing the number of interweavings that each machine direction (MD) yarn makes with the lowermost cross-machine direction (CD) floats. This produces a machine-contacting surface dominated by a large number  
10 of CD yarns which are subjected to abrasion from the machine, thus protecting the strength-providing MD yarns. However, this fabric potentially suffers from the problem of fabric instability in that during a prolonged run it is likely that the fabric weave will come apart at the back.

US 55,03,196 relates to a multilayer dryer fabric comprising two layers of  
15 CD yarns of round cross-section and two systems of MD yarns, the first being of round cross-section and the other consisting of flat yarns. The MD yarns in the first system of MD yarns are interwoven with the CD yarns in the first and second layers in a duplex weave and bind the first and second layers of CD yarns together. The MD yarns in the second system of MD yarns are interwoven with  
20 either the first or second layers of CD yarns.

The knuckles of the first round MD yarn system are said to be within the fabric with respect to the planes defined by the second system of flat MD yarns and as a consequence are said to be less susceptible to degradation by heat and abrasion.

However, this fabric would be extremely sleezy and not particularly stable as the whole structure is bound together by just the central round MD yarns, as the upper and lower MD yarns only offer minimal binding and for the most part float on either external surface. Sleezy fabrics suffer from yarn wear, as a result of  
5 internal friction, and changes in permeability resulting in undesirable differential dewatering of the paper web.

According to the present invention there is provided papermachine clothing comprising machine direction (MD) yarns and cross-machine direction (CD) yarns interwoven in a repeat pattern such that, on at least one side of the  
10 fabric, as part of the weave pattern, two adjacent machine direction yarns extend over the same CD yarn as a pair with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.

According to a second aspect of the present invention there is provided papermachine clothing comprising machine direction (MD) yarns and cross-  
15 machine direction (CD) yarns interwoven in a repeat pattern, wherein the CD yarns are provided in two systems, the first CD yarn system comprising upper and lower yarns, the second CD yarn system comprising at least one yarn, the first and second CD systems being provided alternately throughout the fabric, and wherein the MD yarns are provided in two systems, the first MD yarn system extending  
20 inbetween the upper and lower yarns of the first CD yarn system and over the at least one yarn of the second CD yarn system and individual yarns of the second MD yarn system extending around one of the upper or lower yarns of the first CD yarn system and the at least one yarn of the second CD yarn system, and wherein two adjacent machine direction yarns from different MD yarn systems extend as a

pair over the same CD yarn of the second CD yarn system with one of said pair of MD yarns extending above the other of said pair such that said other yarn is protected from abrasion.

5 The fabric weave of the invention, in arranging some of the machine direction yarns in pairs with half of these being higher than the adjacent yarn in the pair, providing protection against abrasion for the lower MD yarn. Therefore, a considerable number of the strength-providing machine direction yarns are protected from abrasion for a considerable time within a highly stable weave structure.

10 The MD yarns are preferably flat, round or square in cross-section. In a preferred embodiment of the invention the MD yarns are flat having preferred dimensions in the range from 0.30 – 0.45 x 0.50 – 0.80 mm. The CD weft yarns are ideally round or flat. In a preferred embodiment of the invention the CD yarns are round in cross-section. Ideally two systems of CD yarns are used, the first system preferably comprising upper and lower yarns. The diameter of the CD  
15 yarns of the first CD yarn system is ideally in the range from 0.20 – 0.80 mm. The diameter of the CD yarns of the second CD yarn system is ideally in the range from 0.50 – 1.50 mm. The second CD yarn system ideally resides within the fabric with respect to the top and base of the first CD yarn system.

20 The fabric of the invention preferably has a permeability in the range from 90-300 cfm.

In order that the present invention may be more readily understood a specific embodiment thereof will now be described by way of the accompanying drawings in which:-

Fig.1 is a plan view micrograph of one fabric in accordance with the present invention;

Fig.2 is a diagram showing the weave pattern of the fabric of Fig.1;

Fig.3 is a table showing the weave pattern of the fabric of Fig.1;

5 Fig. 4 is a series of micrographs showing the results of abrasion tests on the fabric of Fig. 1;

Fig. 5 is a graph showing the reduction of caliper and tensile strength of the fabric of Fig. 1 as a consequence of abrasion;

Fig. 6 is a graph comparing the reduction of caliper and tensile strength of  
10 the fabric of Fig. 1 with a prior art fabric as a consequence of abrasion; and

Fig. 7 is a graph comparing the reduction of caliper and tensile strength of the fabric of Fig. 1 with a second prior art fabric as a consequence of abrasion

Referring to Figs. 1-3 a papermakers fabric particularly for use in the dryer section of a papermaking machine is woven from flat MD warp yarns (0.36mm x  
15 0.67mm) and two systems of CD wefts/picks which are round in cross-section. The first system of CD yarns comprises a pair of vertically stacked CD yarns, i.e. top (T) and bottom (B) yarns, which are 0.4mm in diameter. The second system of CD yarns comprises larger wefts, arranged alone, which are 0.7mm in diameter. The two CD yarn systems are arranged alternately through the fabric.

20 Fig.2 clearly shows that the weave is a four warp yarn repeat within two warp paths. Warps 1 and 3 follow one path such that the warps hug the external faces of each of the T, B and C weft yarns. Warps 2 and 4 follow an alternative path passing between the upper T and lower B picks of the first CD yarn system and then around weft C. Warps 1 and 3 of the 2<sup>nd</sup> MD yarn system are protected

by warp yarns 2 and 4 of the 1<sup>st</sup> yarn system. It can be seen from Fig. 2 that the weave is symmetrical about a central horizontal plane.

Fig. 3 is a table showing the exact weave pattern of the fabric of Figs. 1 and 2. In the table "LHS" is the left hand weft presenter, "RHS" is the right hand weft presenter and "Dir" is the direction of travel of the weft yarn. As is conventional with tables of this kind a cross in a box underneath any of the sheds/warps means that the specific warp extends over the associated weft.

Therefore we can follow the path of any given warp with reference to the table of Fig. 3 and also the drawing of Fig. 2. For example, the number 1 warp from Figs. 2 and 3 can be seen to pass over T & B weft yarns 1, 2, under C weft yarn 3, over T & B weft yarns 4, 5, under 6, over yarns 7, 8, under 9, over 10, 11 and finally under 12.

As stated previously, the weave is a four warp repeat; i.e. after the first four warps, the pattern repeats so warps 5 and 9 follow the same path as warp 1, warps 6 and 10 follow the same path as warp 2 and so on.

The woven fabric is clearly identified in Figs. 1 and 2, where the abrasion resistance of the fabric is readily apparent. Warps 1 and 3 are protected from abrasion by warp yarns 2 or 4 from the other pair, as they extend around pick C. Warps 1 and 3 follow a convoluted path around the external edges of each of the weft yarns and become tightly wrapped around these yarns. A combination of this 'hugging' effect and the beat up forces of the loom lead to a high degree of crimp. In comparison, yarns 2 and 4 extend around the large weft yarns, but then pass between T and B picks, so taking a far less severe path and subsequently the yarns are less crimped and fall outside warps 1 and 3, thereby protecting them from

abrasion. In all cases, warp 3 is protected from abrasion on the upper surface and warp 1 on the lower surface by warp yarns 2 and 4 alternately. In Fig. 1 it can be seen that the protected yarn 3 is provided to the left of warp 2 and to the right of warp 4.

5           During manufacture of the fabric two beams are required to deliver the warp yarns to the healds due to the difference in the path lengths of the two warp paths of warps 1 and 3 compared to that of warps 2 and 4. Also two weft presenters are used. One weft presenter presents either the top or bottom weft of the first CD yarn system. The other weft presenter presents the larger central weft  
10   yarn of the second CD yarn system.

Referring to the table of Fig. 3, looking across the first row from right to left (i.e. the direction of travel of the weft yarn), it can be seen that the first weft (top) is fired over warps 12, 11 and 10, under warp 9, over warps 8, 7 and 6, under warp 5, and as can be seen in Fig. 2, over warps 4, 3 and 2, but below warp 1.  
15   The second weft selected is a bottom weft and this is picked up by the shuttle on the left hand side and taken across the loom. As can be seen in Fig. 2, weft 2 passes under warps 1 and 2, above 3 and then below 4. It then continues (not visible in Fig. 2), under warps 5 and 6, over 7, under 8, 9 and 10, over 11 and under 12.

20           The protected MD yarns 1,3 are advantageously selected to form the seam loops or to bind to a jointing means such as a spiral.

Fig. 4 is a series of twelve micrographs, taken periodically after the fabric of Fig. 1 has been subjected to abrasion. The abrasion story is illustrated from 0 to 1632 hours.

After 96 hours, it can be seen that the uppermost warp knuckles have just started to be abraded and this continues gradually until micrograph 6. After 888 hours (micrograph 7) it can be seen that the most prominent weft yarn T is beginning to be abraded. At this point, an interesting phenomenon was observed.

5 Once the abrasion reaches weft yarn T, it seems to halt at this point, the weft yarn T thus protecting the second warp of the pair from further abrasion. The abrasion tests were stopped after 1632 hours. At this point, the abrasion seemed not to be any further advanced than after 888 hours, and there still appeared to be plenty of life remaining in the fabric. The micrographs clearly show that the second warp

10 yarn of each warp pair is entirely free of abrasion for many hours after the onset of abrasion in its neighbouring yarn.

Figs. 5 to 7 show the results of a number of tests which were carried out to discover, in the same time frames, how the tensile strength and caliper of the fabric were affected by the abrasion. These have been plotted for the fabric of the invention alone, in Fig. 5, and as compared with two prior art dryer fabrics -- "Art 1" & "Art 2", in Figs. 6 and 7 respectively.

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In Fig. 5 it can be seen that the caliper of the fabric of the invention is only reduced by just over 13% of its original value after 1632 hours, and that the tensile strength until 1392 hours was 70% of its original value, but then fell fairly steeply

20 to just over 45% at the end of the trial. This value though is well above the critical tensile value, i.e. the value below which the fabric is rendered unusable, of just under 30%.



Fig. 6 shows that the fabric of the invention performs well against the "Art 1" dryer fabric which only has a lifetime of around 240 hours, at which point the critical tensile strength had been surpassed.

In Fig. 7 the performance of the fabric of the invention is shown as against the "Art 2" dryer fabric. Here the caliper percentage figures are very similar until around 1536 hours, at which time, Art 2 shows a sharper decline in caliper. The tensile strength of the fabric of the invention is consistently lower than that of Art 2, but after 1632 hours the Art 2 fabric had surpassed its critical tensile value and became unusable, whereas the fabric of the invention still had 45% of its original tensile strength.

It is to be understood that the above disclosed embodiment of the invention is by way of illustration only. Many modifications and variations are possible.